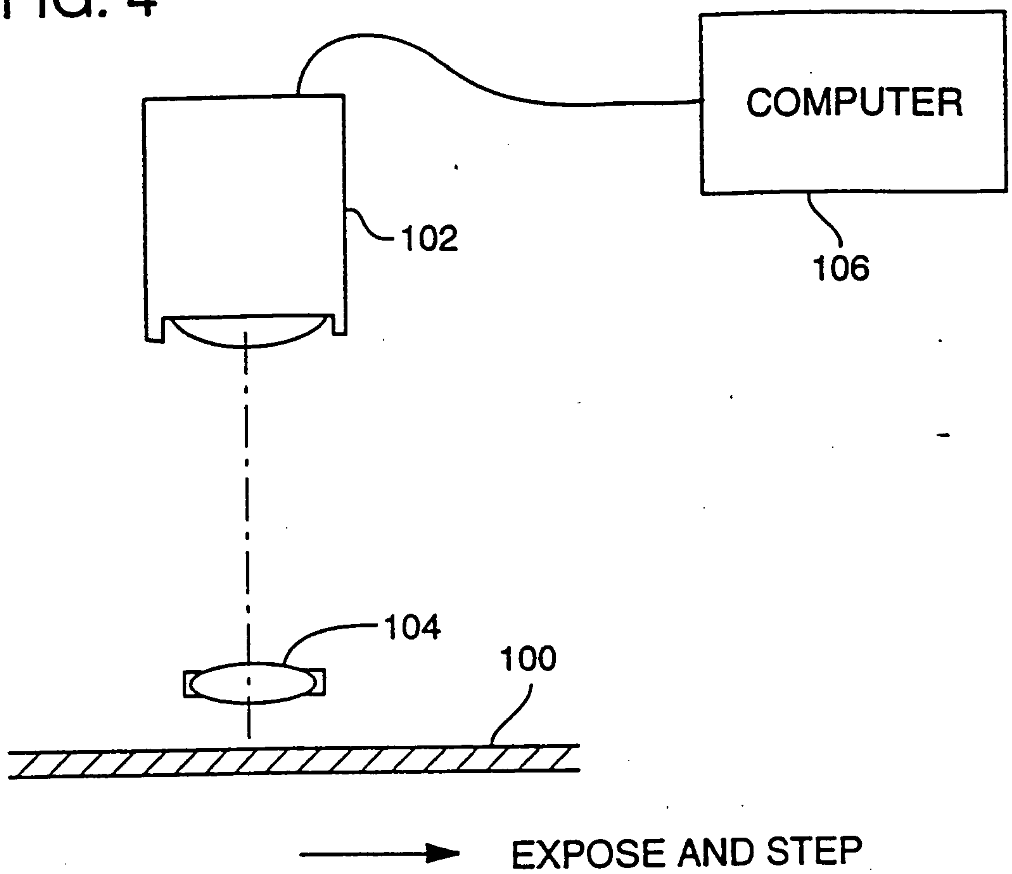
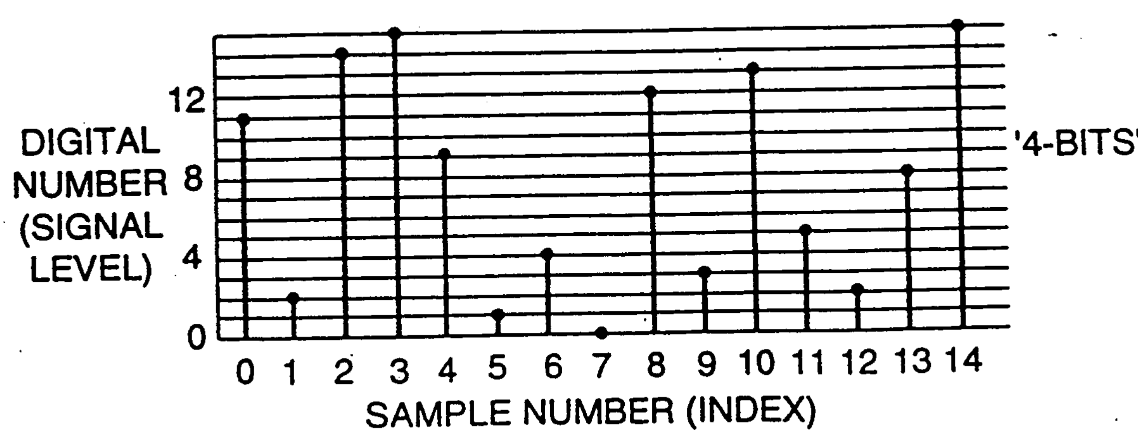
FIG. 4



COMPUTER
102
106
104
100
EXPOSE AND STEP

FIG. 1



DIGITAL NUMBER (SIGNAL LEVEL)
0
4
8
12
'4-BITS'
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
SAMPLE NUMBER (INDEX)

FIG. 2

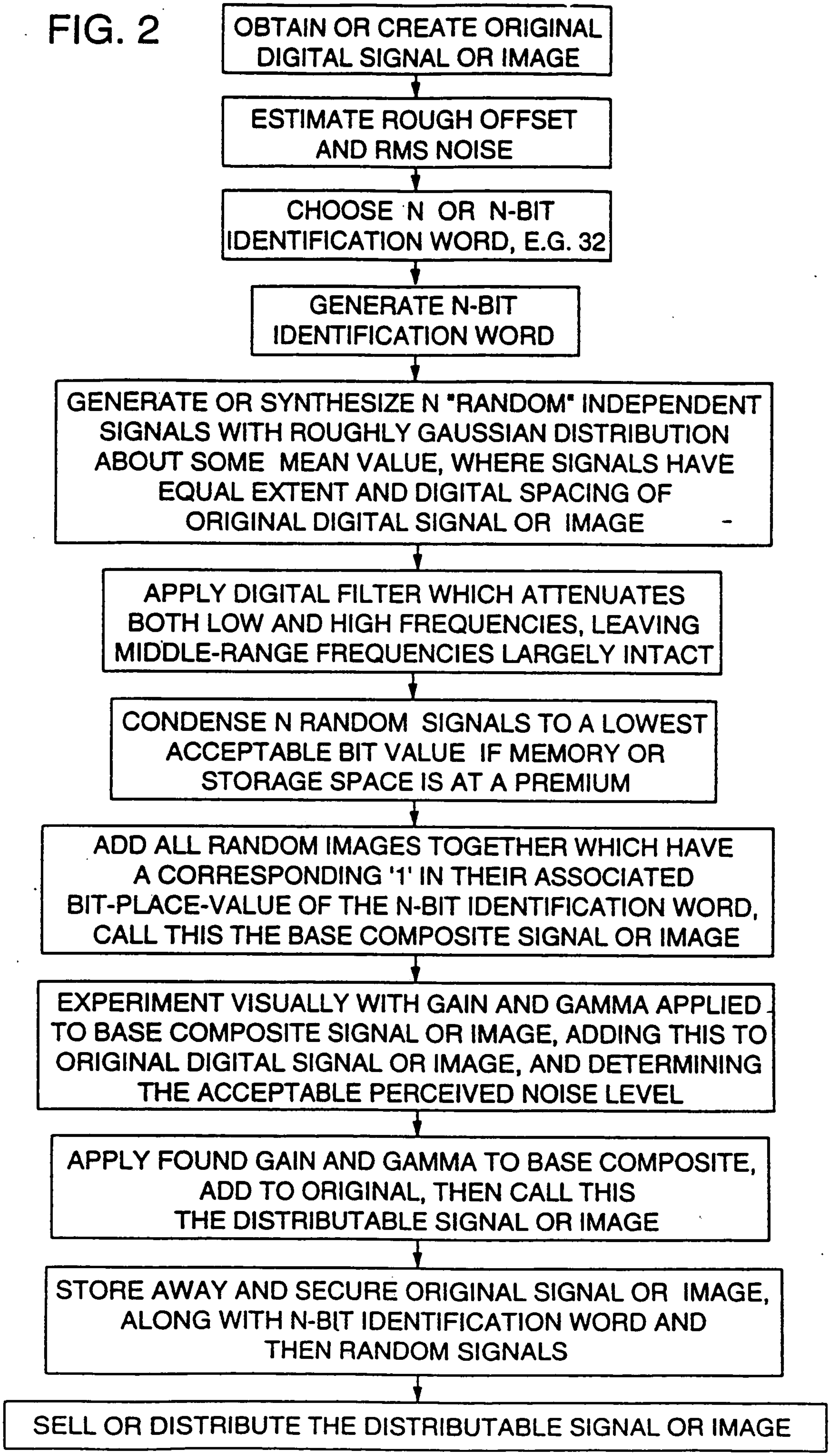

OBTAIN OR CREATE ORIGINAL DIGITAL SIGNAL OR IMAGE
ESTIMATE ROUGH OFFSET AND RMS NOISE
CHOOSE N OR N-BIT IDENTIFICATION WORD, E.G. 32
GENERATE N-BIT IDENTIFICATION WORD
GENERATE OR SYNTHESIZE N "RANDOM" INDEPENDENT SIGNALS WITH ROUGHLY GAUSSIAN DISTRIBUTION ABOUT SOME MEAN VALUE, WHERE SIGNALS HAVE EQUAL EXTENT AND DIGITAL SPACING OF ORIGINAL DIGITAL SIGNAL OR IMAGE
APPLY DIGITAL FILTER WHICH ATTENUATES BOTH LOW AND HIGH FREQUENCIES, LEAVING MIDDLE-RANGE FREQUENCIES LARGELY INTACT
CONDENSE N RANDOM SIGNALS TO A LOWEST ACCEPTABLE BIT VALUE IF MEMORY OR STORAGE SPACE IS AT A PREMIUM
ADD ALL RANDOM IMAGES TOGETHER WHICH HAVE A CORRESPONDING '1' IN THEIR ASSOCIATED BIT-PLACE-VALUE OF THE N-BIT IDENTIFICATION WORD, CALL THIS THE BASE COMPOSITE SIGNAL OR IMAGE
EXPERIMENT VISUALLY WITH GAIN AND GAMMA APPLIED TO BASE COMPOSITE SIGNAL OR IMAGE, ADDING THIS TO ORIGINAL DIGITAL SIGNAL OR IMAGE, AND DETERMINING THE ACCEPTABLE PERCEIVED NOISE LEVEL
APPLY FOUND GAIN AND GAMMA TO BASE COMPOSITE, ADD TO ORIGINAL, THEN CALL THIS THE DISTRIBUTABLE SIGNAL OR IMAGE
STORE AWAY AND SECURE ORIGINAL SIGNAL OR IMAGE, ALONG WITH N-BIT IDENTIFICATION WORD AND THEN RANDOM SIGNALS
SELL OR DISTRIBUTE THE DISTRIBUTABLE SIGNAL OR IMAGE

FIG. 3

OBTAIN DIGITAL OR NON-DIGITAL COPY OF SUSPECT SIGNAL OR IMAGE

↓

DIGITIZE IF NOT ALREADY DIGITAL

↓

CUT AND MASK PORTION OF SIGNAL OR IMAGE BELIEVED TO BE SUSPECT (ONLY IF ENTIRE SIGNAL OR IMAGE IS NOT SUSPECT)

↓

PROCURE ORIGINAL DIGITAL SIGNAL OR IMAGE AND CUT AND MASK TO ROUGHLY THE SAME LOCATION OR SEQUENCE

↓

VISUALLY RESCALE AND REGISTER THE CUT-OUT SUSPECT SIGNAL TO THE CUT-OUT ORIGINAL SIGNAL

↓

RUN THROUGH SEARCH PROGRAM WITH MEAN SQUARED ERROR AS CRITERIA AND X OFFSET, Y OFFSET, AND SCALE AS THE THREE VARIABLES

↓

APPLY X OFFSET, Y OFFSET, AND SCALE TO CUT-OUT SUSPECT, THEN RESAMPLE ONTO EXACT GRID AND CUT-OUT OF ORIGINAL SIGNAL

↓

RUN THROUGH SEARCH PROGRAM WITH MEAN SQUARED ERROR AS CRITERIA AND DC OFFSET, GAIN, AND GAMMA AS THE THREE VARIABLES; APPLY TO SUSPECT

↓

SUBTRACT ORIGINAL FROM SUSPECT, GIVING DIFFERENCE SIGNAL OR IMAGE

↓

STEP THROUGH ALL N RANDOM INDEPENDENT SIGNALS, MASKED AS ORIGINAL AND CROSS-CORRELATED WITH DIFFERENCE SIGNAL IN IMMEDIATE NEIGHBORHOOD OF REGISTRATION POINTS

↓

FIND 0 AND 1 LEVEL BY AVERAGING FIRST FOUR 0101 CODE VALUES

↓

ASSIGN EITHER A 0 OR A 1 TO EACH CROSS-CORRELATION RESULT DEPENDING ON PROXIMITY TO THE AVERAGES OF PREVIOUS STEP

↓

CHECK RESULT AGAINST SECURED IDENTIFICATION NUMBER

↓

PROSECUTE IF IT MATCHES? OR AT LEAST SEND A NASTY LETTER DEMANDING RECOMPENSE

FIG. 5

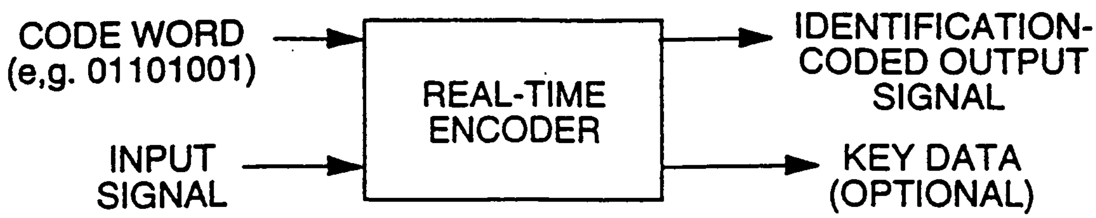
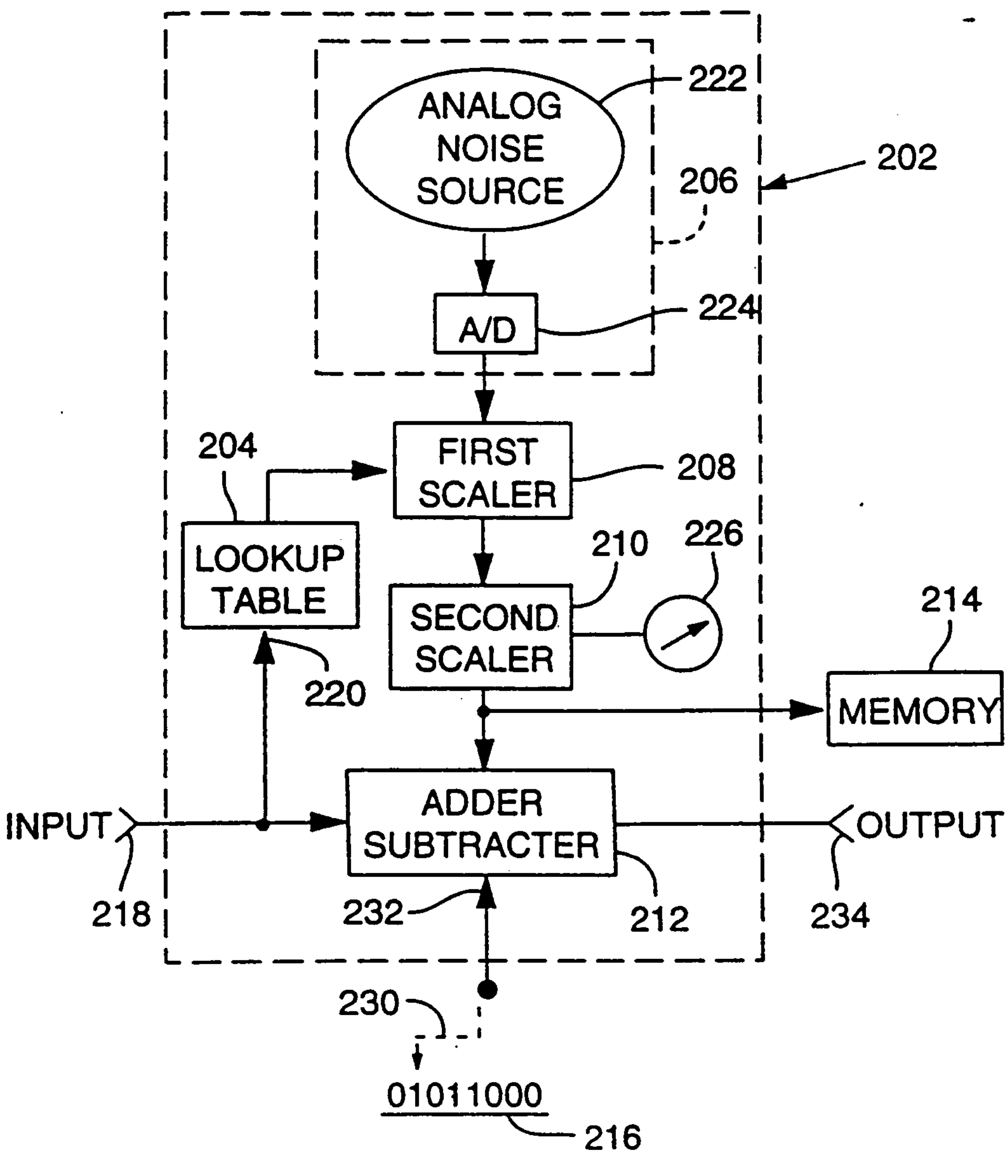

CODE WORD
(e,g. 01101001)
INPUT
SIGNAL
REAL-TIME
ENCODER
IDENTIFICATION-
CODED OUTPUT
SIGNAL
KEY DATA
(OPTIONAL)

FIG. 6


ANALOG
NOISE
SOURCE
222
202
206
A/D
224
FIRST
SCALER
204
208
LOOKUP
TABLE
210
226
SECOND
SCALER
214
220
MEMORY
INPUT
ADDER
SUBTRACTER
OUTPUT
218
232
212
234
230
01011000
216

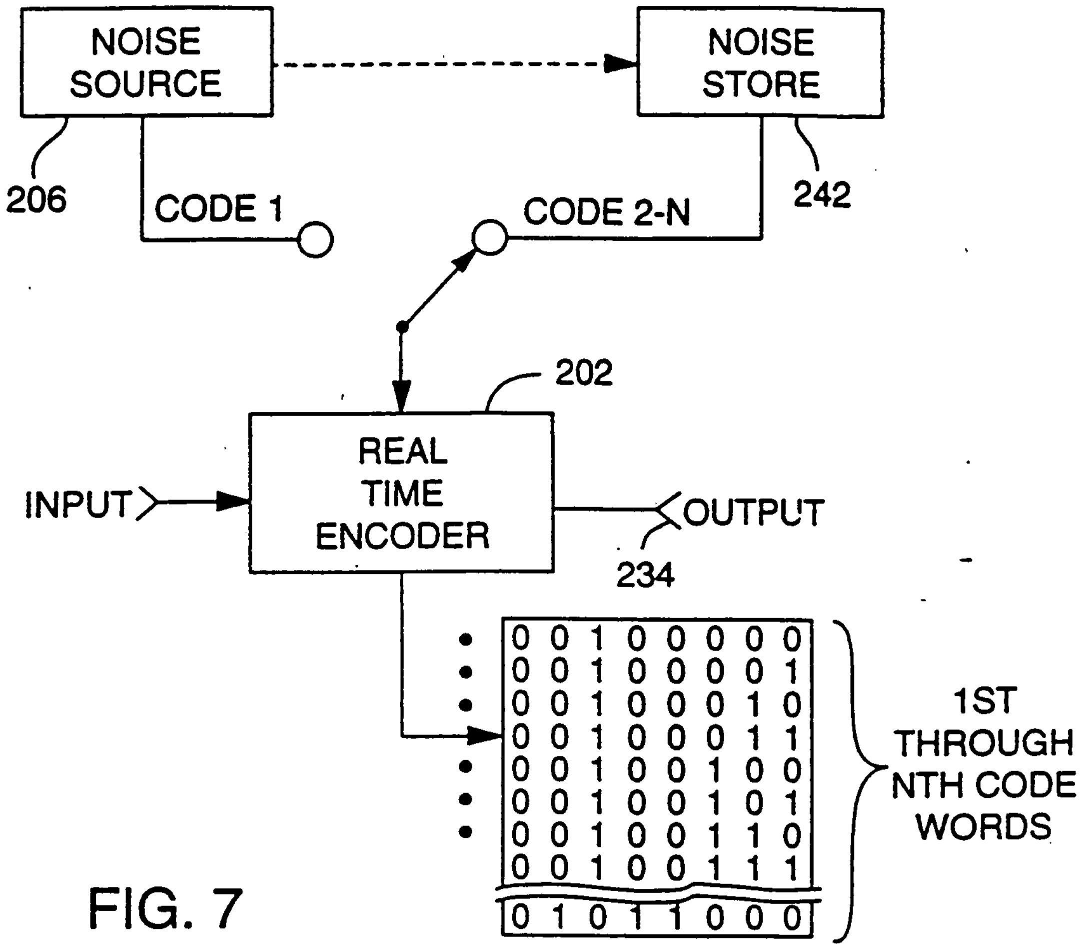

NOISE SOURCE
NOISE STORE
206
242
CODE 1
CODE 2-N
202
REAL TIME ENCODER
INPUT
OUTPUT
234
0 0 1 0 0 0 0 0
0 0 1 0 0 0 0 1
0 0 1 0 0 0 1 0
0 0 1 0 0 0 1 1
0 0 1 0 0 1 0 0
0 0 1 0 0 1 0 1
0 0 1 0 0 1 1 0
0 0 1 0 0 1 1 1
0 1 0 1 1 0 0 0
1ST THROUGH NTH CODE WORDS

FIG. 7

FIG. 8

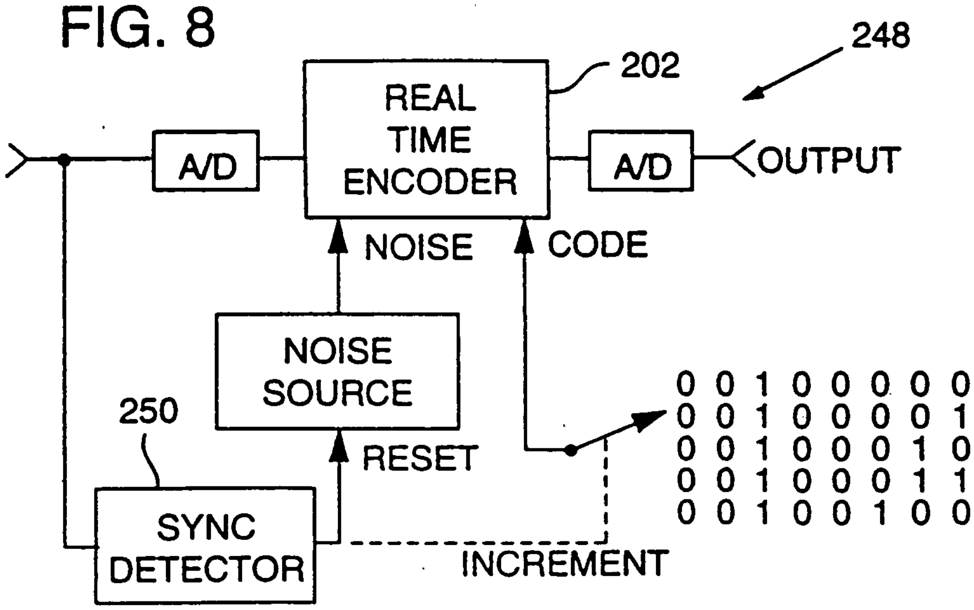

248
202
REAL TIME ENCODER
A/D
A/D
OUTPUT
NOISE
CODE
NOISE SOURCE
250
RESET
SYNC DETECTOR
INCREMENT
0 0 1 0 0 0 0 0
0 0 1 0 0 0 0 1
0 0 1 0 0 0 1 0
0 0 1 0 0 0 1 1
0 0 1 0 0 1 0 0

FIG. 9A

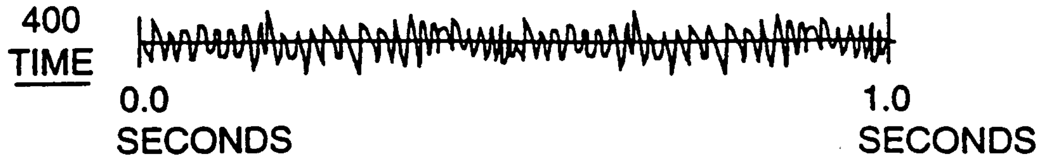


FIG. 9B

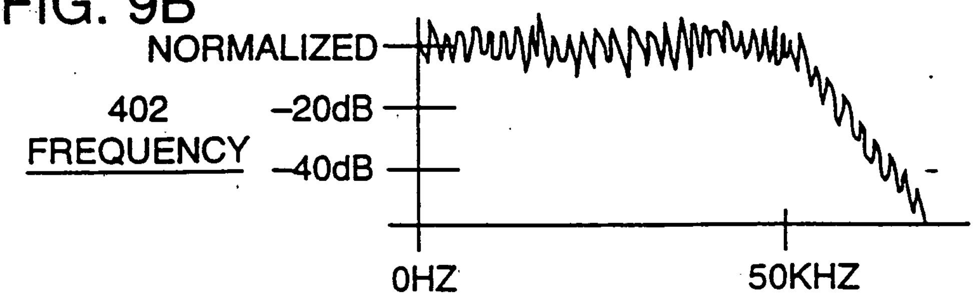


FIG. 9C

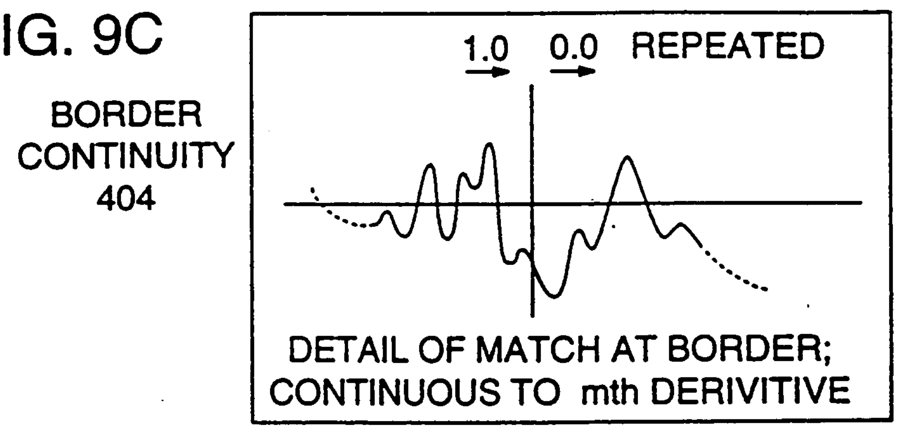


FIG. 10

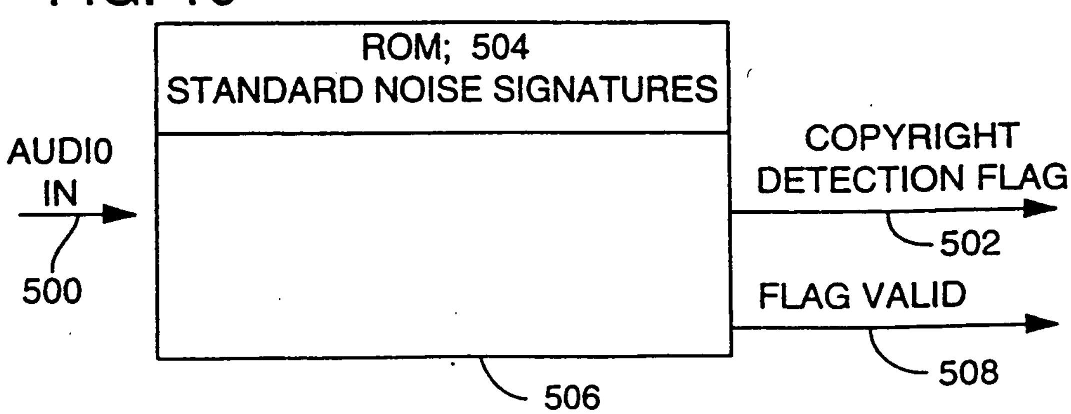


FIG. 11

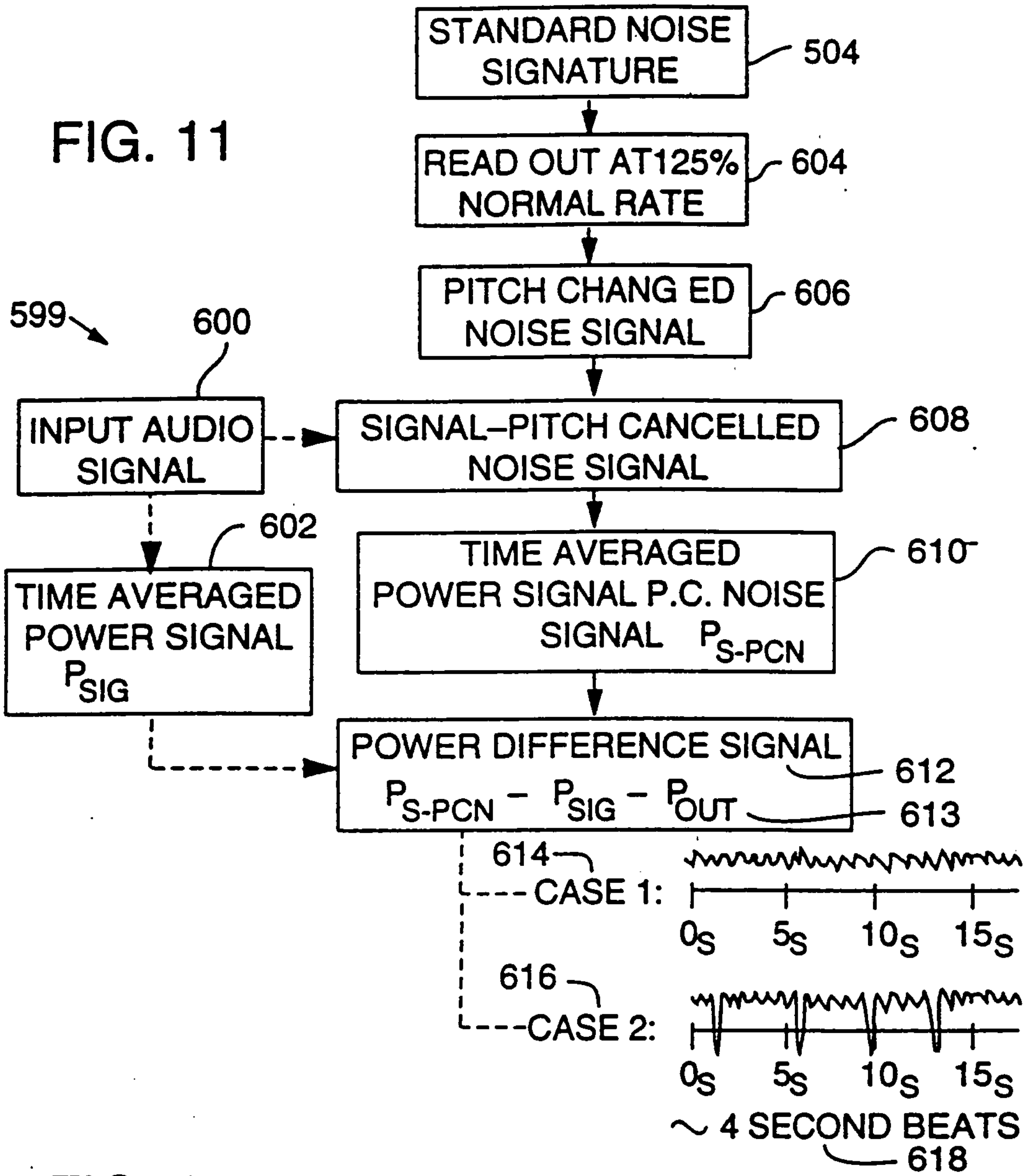

STANDARD NOISE SIGNATURE
504
READ OUT AT125% NORMAL RATE
604
PITCH CHANG ED NOISE SIGNAL
606
599
600
INPUT AUDIO SIGNAL
SIGNAL–PITCH CANCELLED NOISE SIGNAL
608
602
TIME AVERAGED POWER SIGNAL P_{SIG}
TIME AVERAGED POWER SIGNAL P.C. NOISE SIGNAL P_{S-PCN}
610
POWER DIFFERENCE SIGNAL
$P_{S-PCN} - P_{SIG} - P_{OUT}$
612
613
614
CASE 1:
0_S 5_S 10_S 15_S
616
CASE 2:
0_S 5_S 10_S 15_S
~ 4 SECOND BEATS
618

FIG. 12

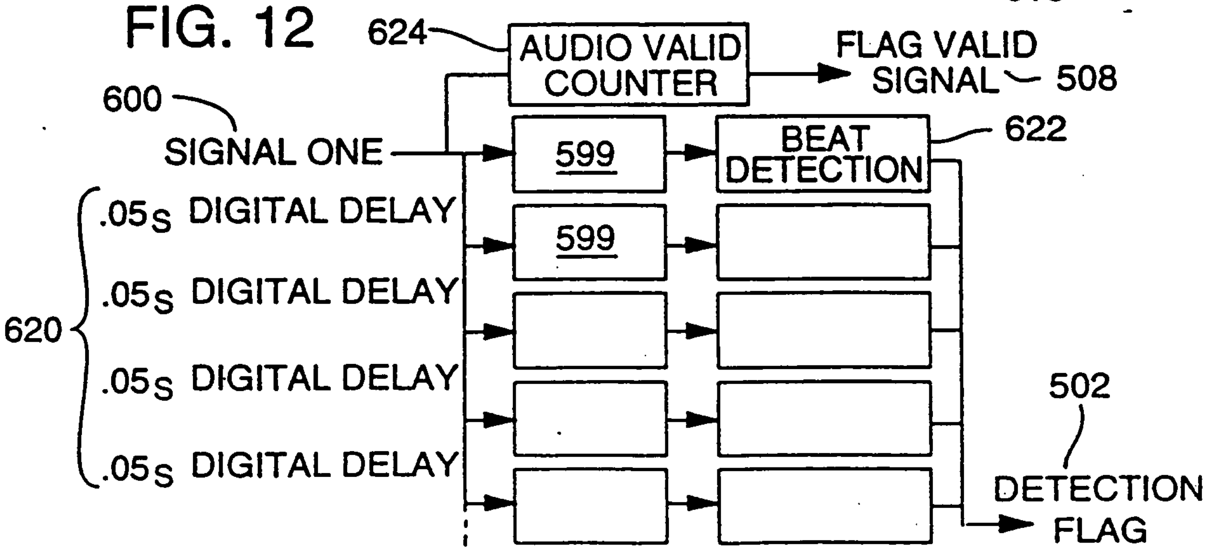
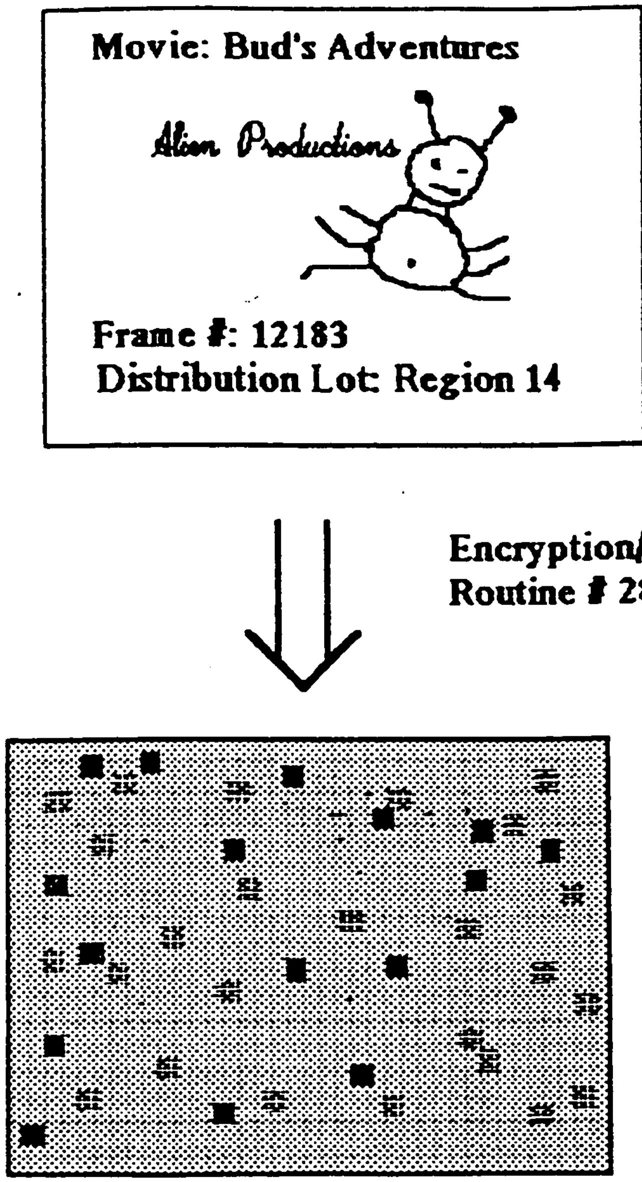

624
AUDIO VALID COUNTER
FLAG VALID SIGNAL
508
600
SIGNAL ONE
599
BEAT DETECTION
622
.05s DIGITAL DELAY
599
.05s DIGITAL DELAY
620
.05s DIGITAL DELAY
.05s DIGITAL DELAY
502
DETECTION FLAG

Figure 13

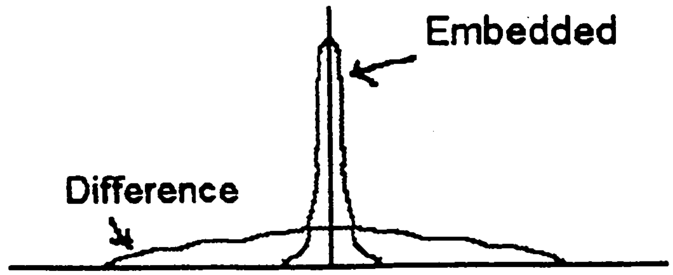


700

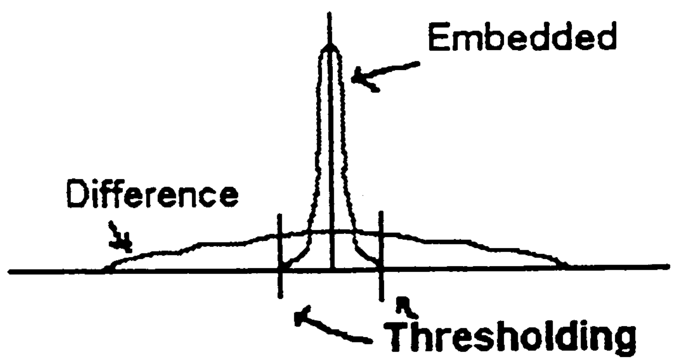
Encryption/Scrambling
Routine # 28 ,702

704 Pseudo-Random Master Snowy Image
(Scaled Down and Added to Frame 12183)

Figure 14

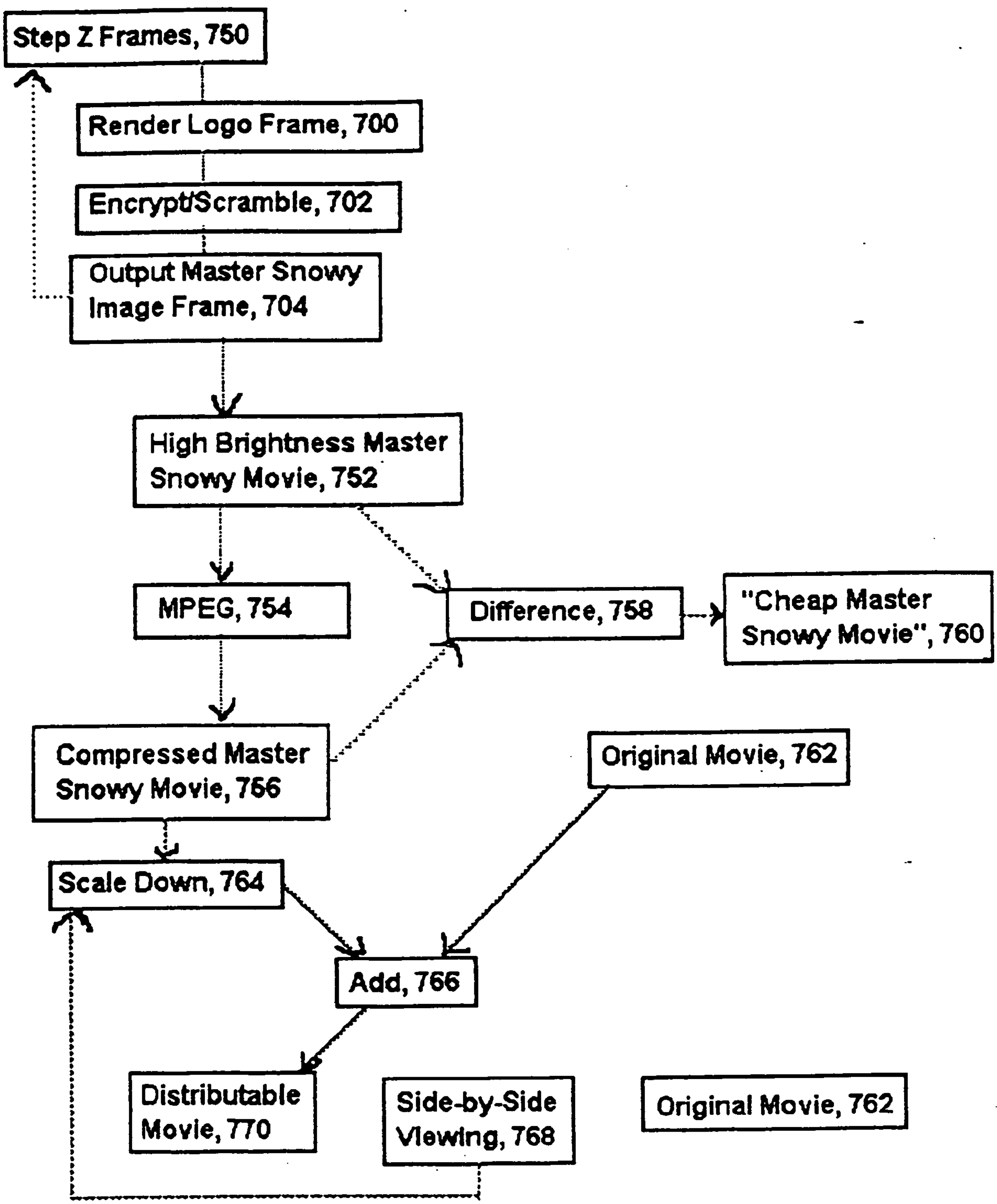


720, Mean-Removed Histograms of Difference Signal and Known Embedded Code Signal



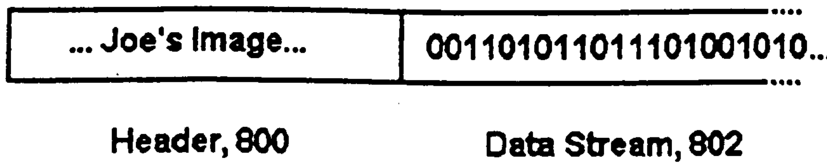
722, Mean-Removed Histograms of First Derivatives (or scaler gradients in the case of an image)

Figure 15

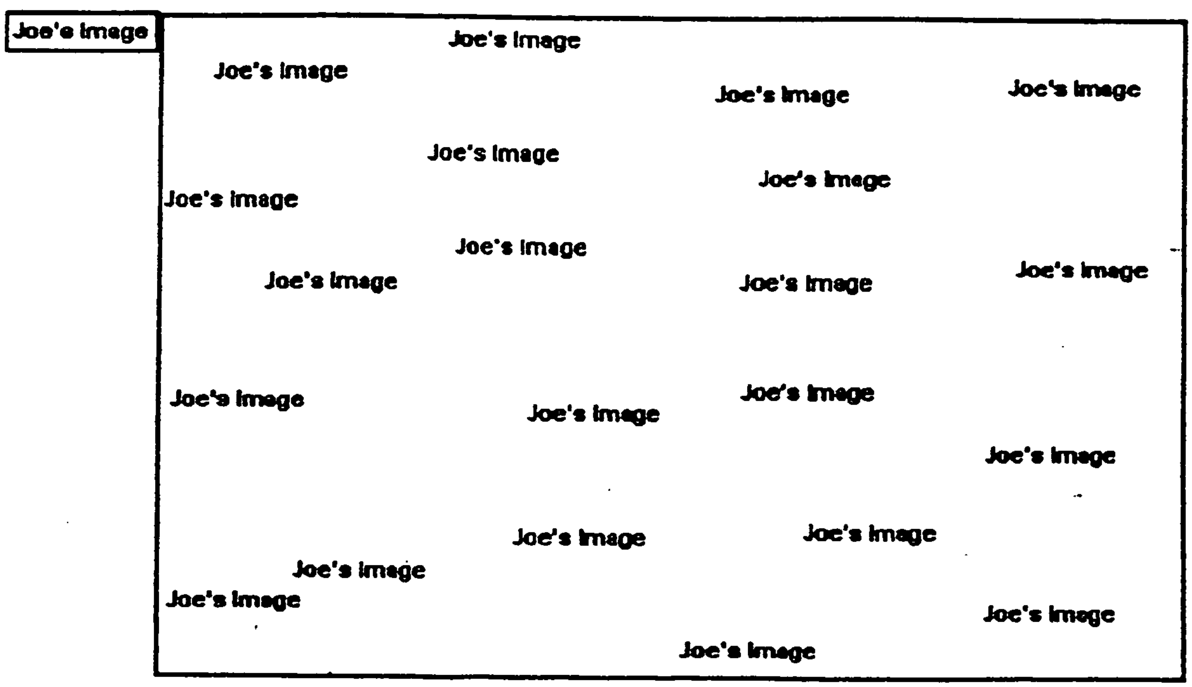


Step Z Frames, 750
Render Logo Frame, 700
Encrypt/Scramble, 702
Output Master Snowy Image Frame, 704
High Brightness Master Snowy Movie, 752
MPEG, 754
Difference, 758
"Cheap Master Snowy Movie", 760
Compressed Master Snowy Movie, 756
Original Movie, 762
Scale Down, 764
Add, 766
Distributable Movie, 770
Side-by-Side Viewing, 768
Original Movie, 762

Figure 16

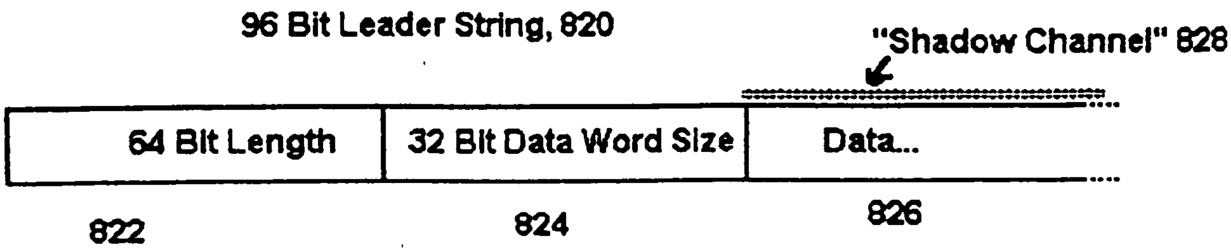


... Joe's Image...
0011010110111101001010...
Header, 800
Data Stream, 802



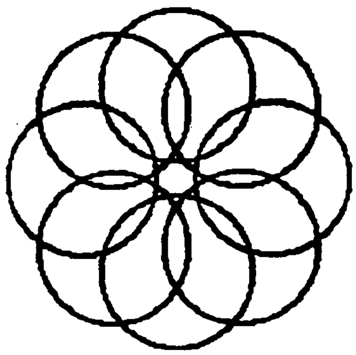
Joe's image

Figure 17

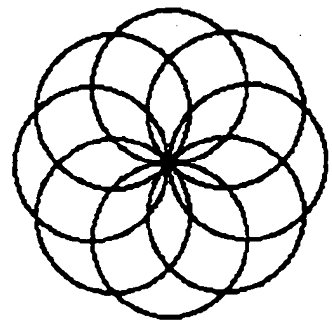


Universal Empirical Data Format

Figure 18

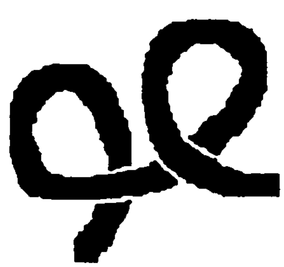


Supra-radial Knots, 850



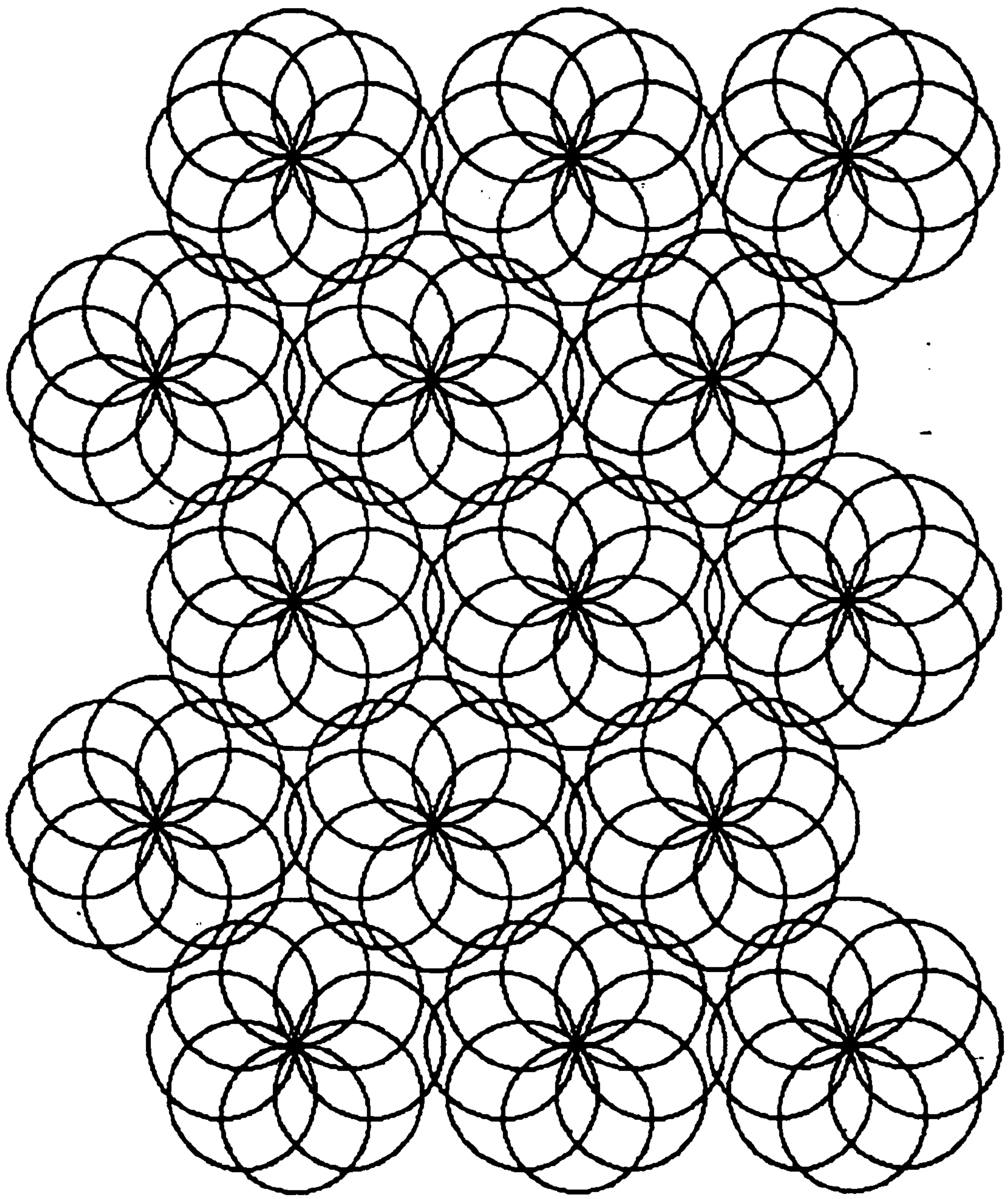
Radial Knots, 852

854, One basic concept of the knot is an overlapping of one strand of finite width over another strand



864, Another basic concept is the symetric weaving of overlaps

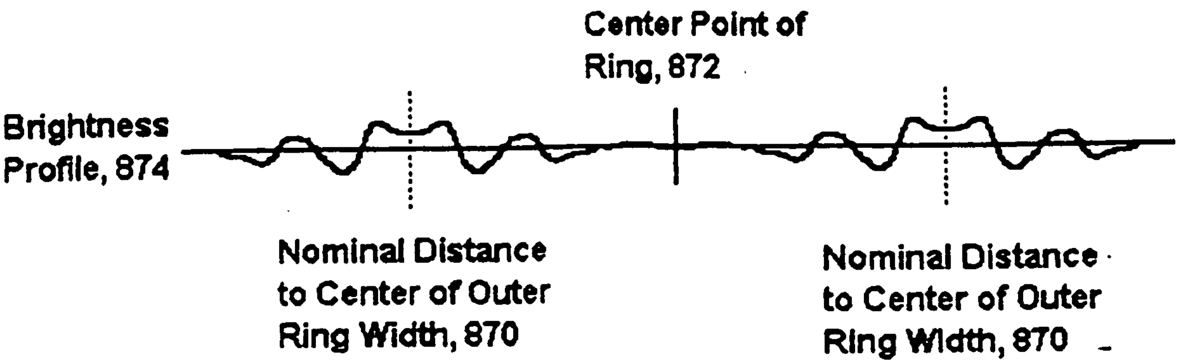
Figure 19



866, Quest for Mosaiced Knot Patterns which "Cover" and are Coextensvie with Original Image;

All elemental knot patterns can convey the same information, such as a signature, or each can convey a new message in a steganographic sense

Figure 20



876, 2-D brightness of phase-only filtered ring is similar to the above brightness pattern rotated about central point of ring :

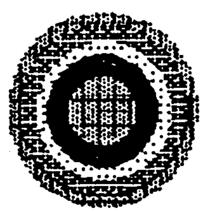


Figure 21 A

C	2C	C
2C	4C	2C
C	2C	C

where C = 1 / 16

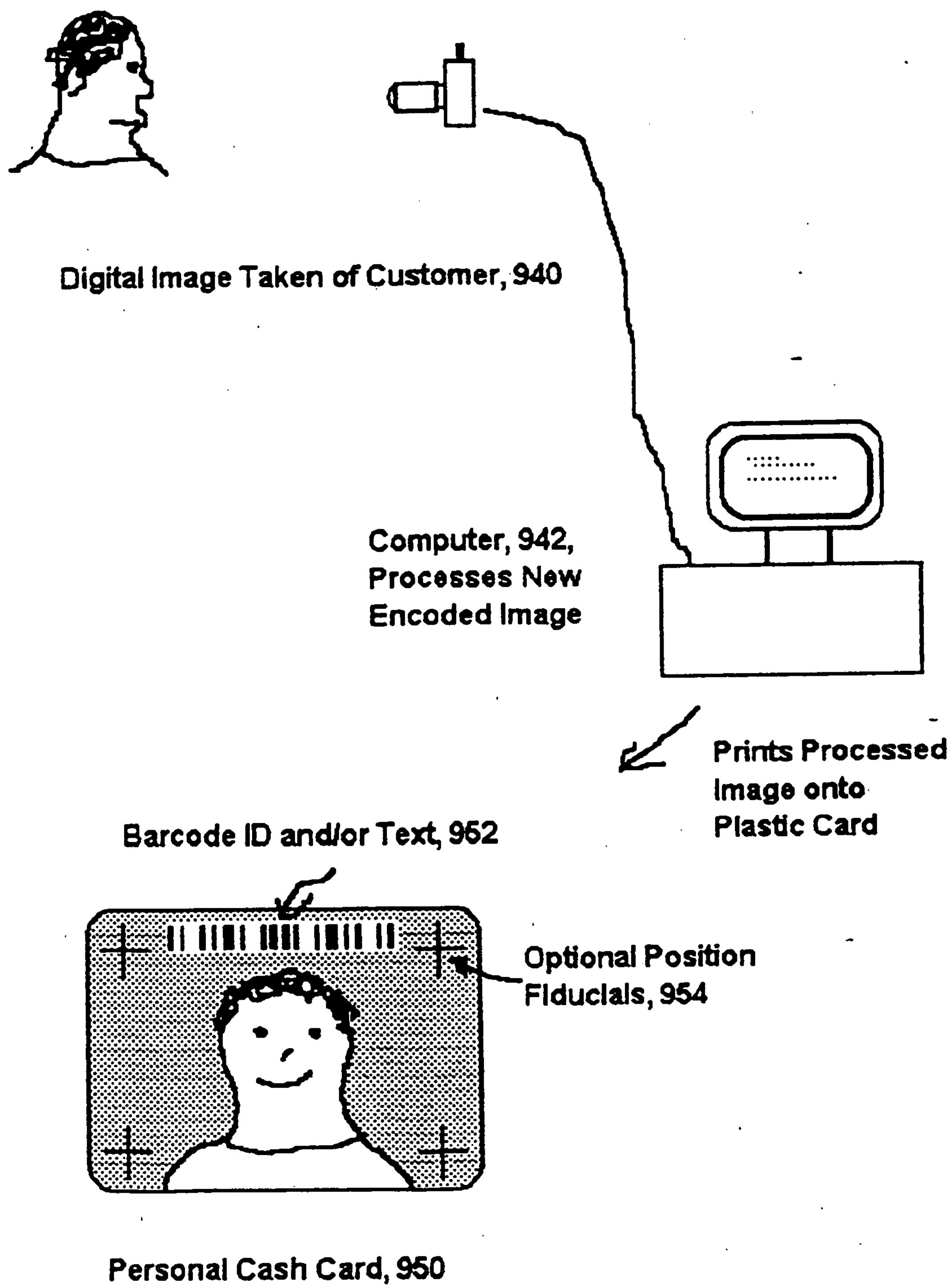
Elementary Bump, 900
(Defined grouping of pixels with weight values)

2		3		4		5		6		7		0
6		7		0		1		2		3		4
					C	2C	C					
2		3		4	2C	4C	2C	6		7		0
					C	2C	C					
6		7		0		1		2		3		4

Example of how elementary bumps, 900, would be assigned locations in an image, and those locations would be associated with a corresponding bit plane in the N-bit word, here taken as N=8 with indexes of 0-7. One location, associated with bit plane "5", has the overlay of the bump profile depicted.

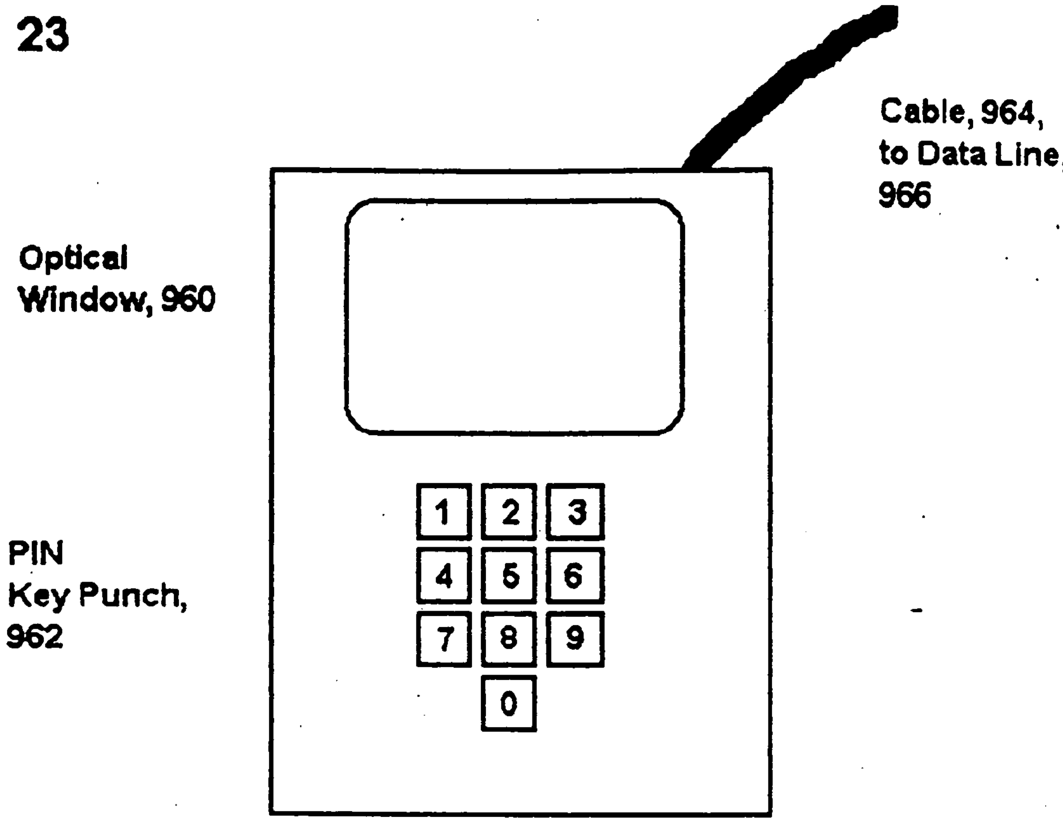
FIG. 21B

Figure 22



Digital Image Taken of Customer, 940
Computer, 942, Processes New Encoded Image
Prints Processed Image onto Plastic Card
Barcode ID and/or Text, 952
Optional Position Fiducials, 954
Personal Cash Card, 950

Figure 23

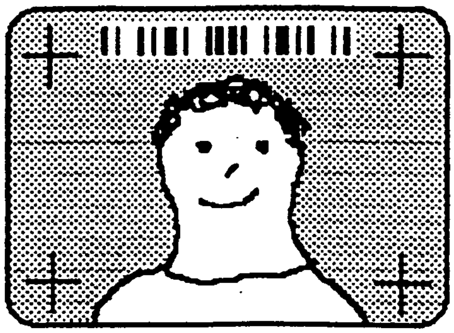


Low Cost Point-of-Sale Optical Reader, 958

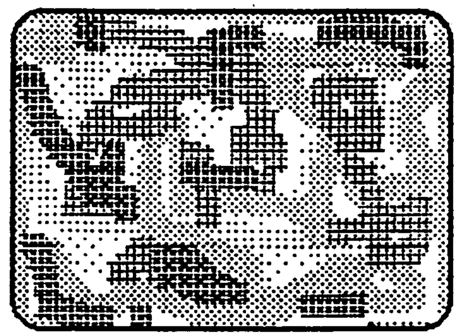
Contains rudimentary optical scanner, memory buffers, communications devices, and microprocessor

Consumer merely places card into window and can, at their pre-arranged option, either type in a Personal Identification Number (PIN, for added security) or not. The transaction is approved or disapproved within seconds.

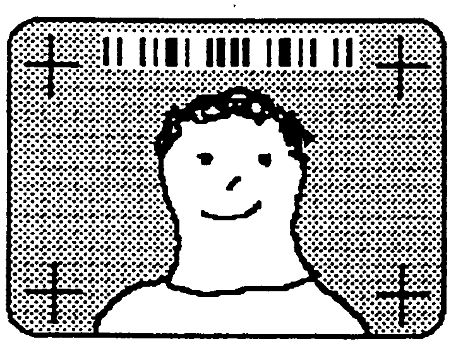
Figure 24



Original Digital Image with Barcode and Fiducials Added, 970



Computer generates Master Snowy Image 972, which is generally orthogonal to Original Image at left



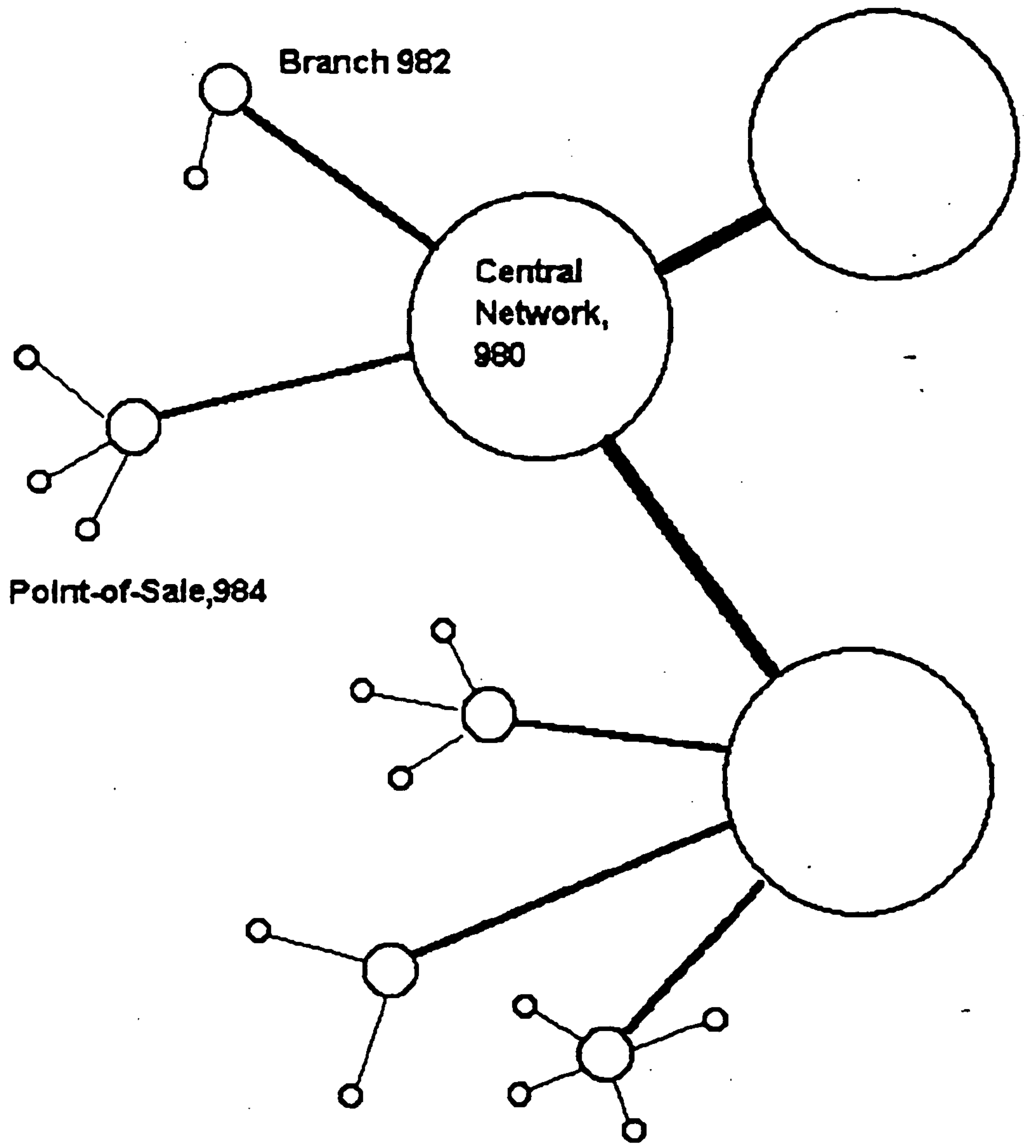
Combined to form Personal Cash Card, 950

Figure 25 Typical Transaction Steps

1. Reader scans images on card, stores in memory, extracts persons ID
2. Optional: User keys in PIN number
3. Reader calls central account data network, handshakes
4. Reader sends ID, (PIN), merchant information, and requested transaction amount to central network
5. Central Network verifies ID, PIN, Merchant info, and account balance
6. If OK, Central Network generates twenty four sets of sixteen distinct random numbers, where the random numbers are indexes to a set of 64K orthogonal spatial patterns
7. Central Network transmits first OK, and the sets of random numbers
8. Reader steps through the twenty four sets
   - 8A. Reader adds together set of orthogonal patterns
   - 8B. Reader performs dot product of resultant pattern and card scan, stores result
9. Reader transmits the twenty four dot product results to Central Network
10. Central Network checks results against master
11. Central Network sends final approval or denial
12. Central Network debits Merchant Account, credits Card account

Figure 26

The Negligible-Fraud Cash Card System



A basic foundation of the cash card system is a 24 hour information network, where both the stations which create the physical cash cards, 950, and the point-of-sales, 984, are all hooked up to the same network conitnuously

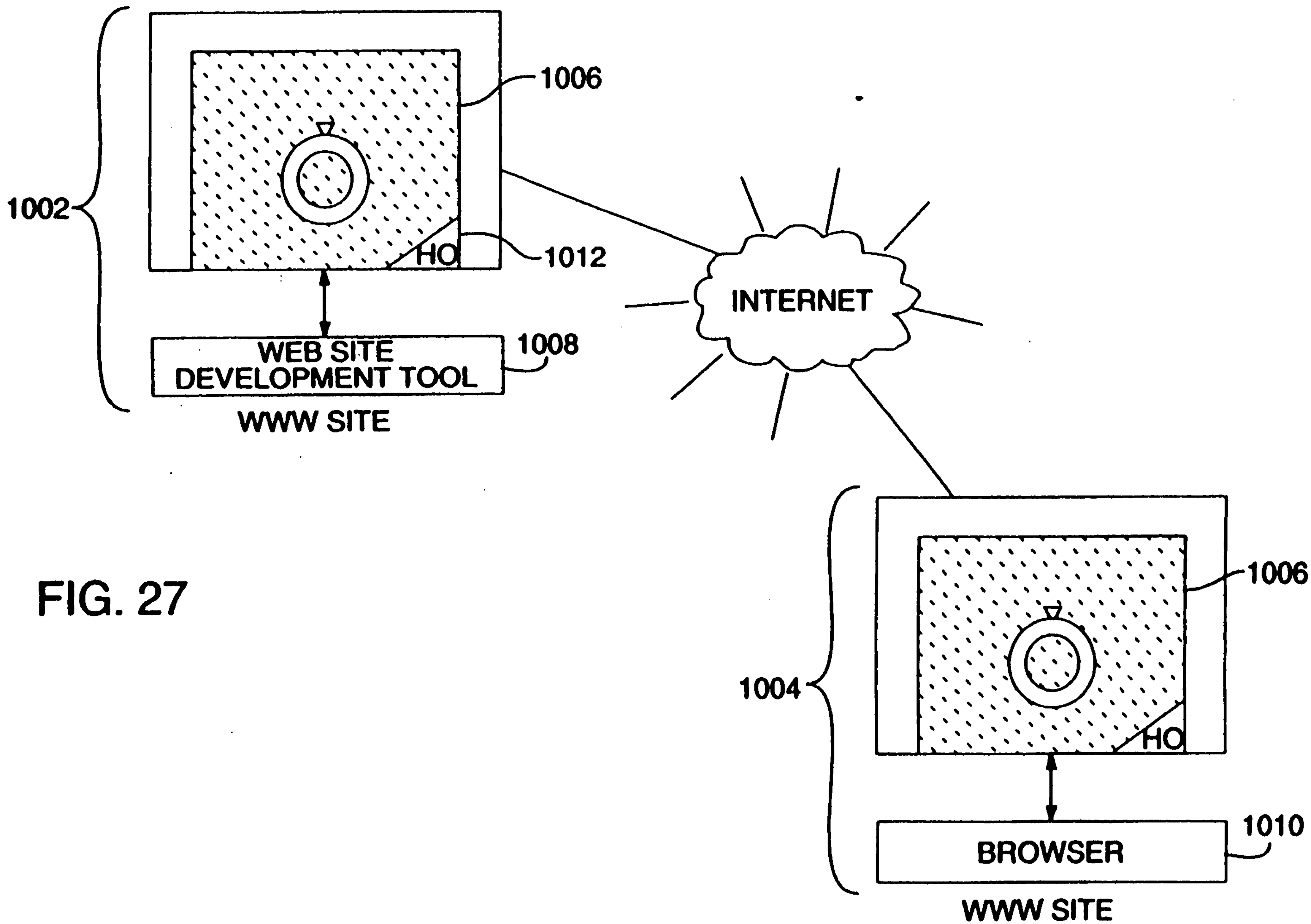
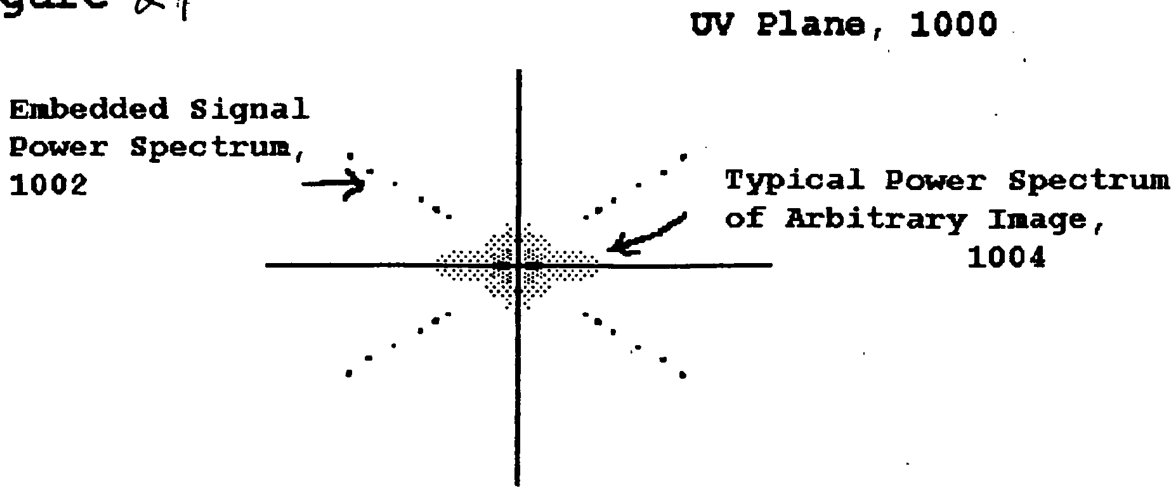

1002
1006
1012
HO
WEB SITE
DEVELOPMENT TOOL
1008
WWW SITE
INTERNET
1004
1006
HO
BROWSER
1010
WWW SITE

FIG. 27

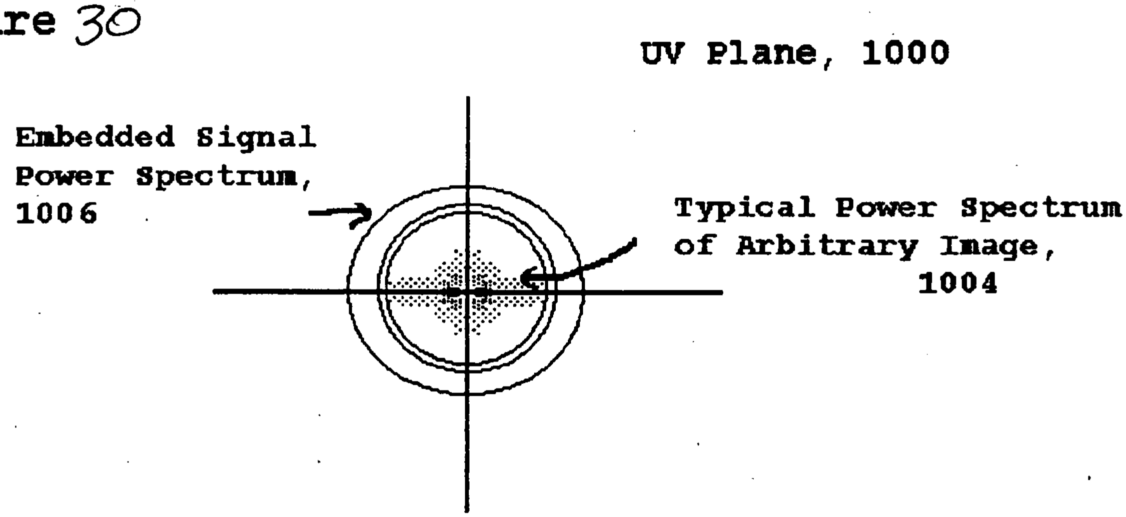
Fig. 28

Figure 29



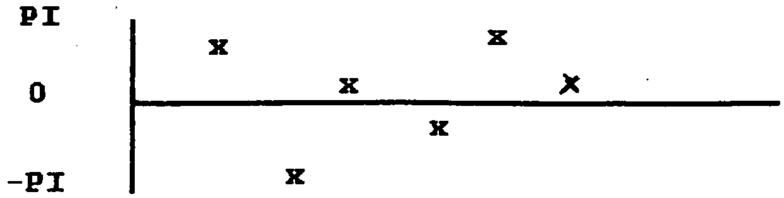
Non-harmonic spatial frequencies along the 45 degree axes, giving rise to a weave-like cross-hatching pattern in the spatial domain

Figure 30

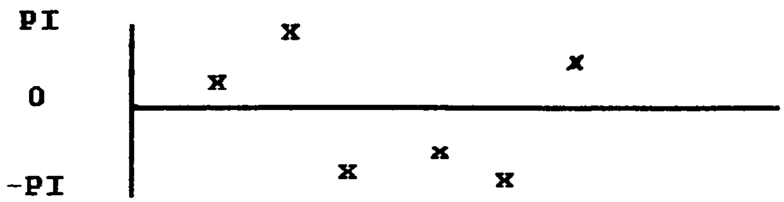


Non-harmonic concentric circles in UV plane, where phase hops quasi-randomly along each circle, giving rise to pseudo random looking patterns in the spatial domain

Figure 31A



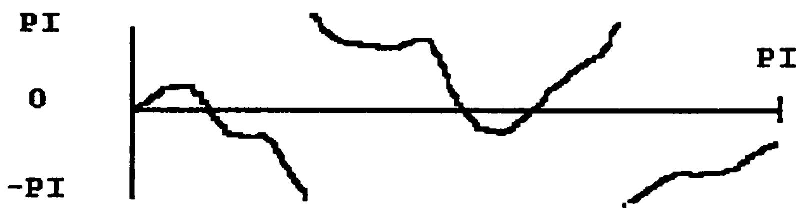
Phase of spatial frequencies along forward 45 degree axes, 1008



Phase of spatial frequencies along backward 45 degree axes, 1010

FIG. 31B

Figure 32A



Phase of spatial frequencies along first concentric ring, 1012

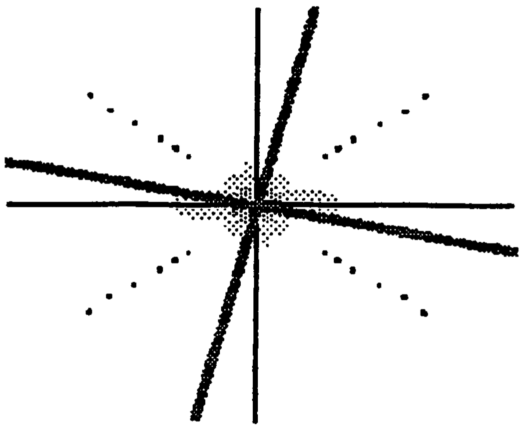
FIG. 32B

Phase of spatial frequencies along second concentric ring 1014

FIG 32C

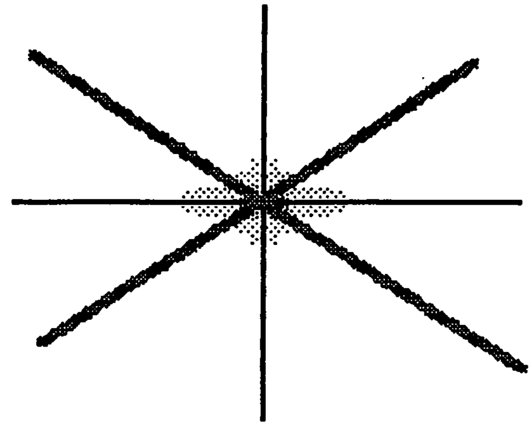
Phase of spatial frequencies along third concentric ring, 1016

Figure 33A



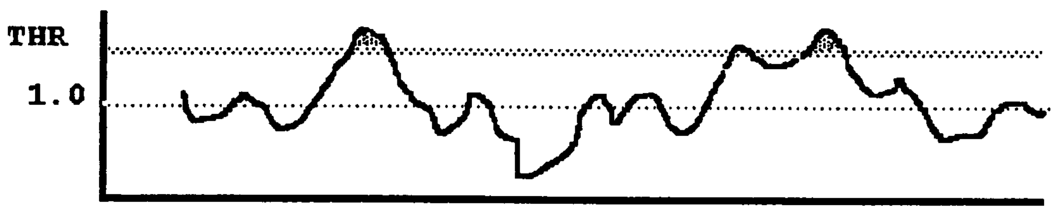
Angle A 1018

FIG. 33B



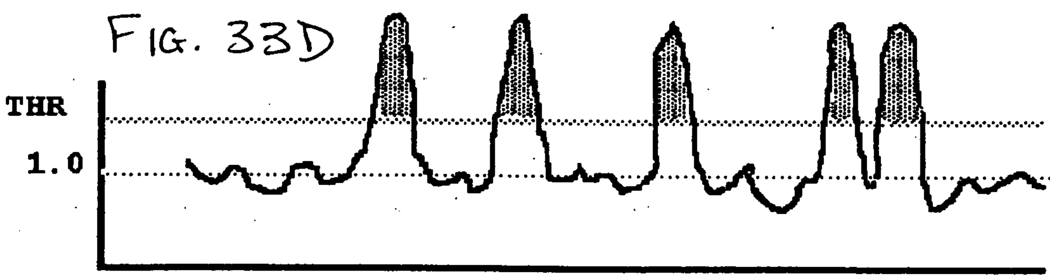
Angle B 1020

FIG. 33C



Power profile along Angle A, as normalized by its own moving average; only a minimal amount exceeds threshold, giving a small integrated value 1022

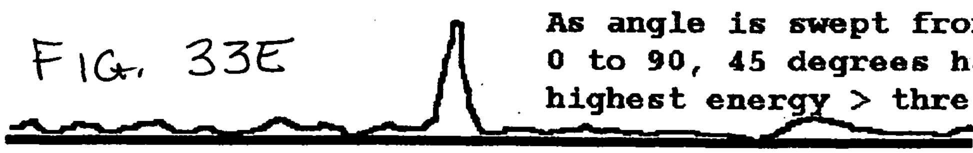
FIG. 33D



Power profile along Angle B, as normalized by its own moving average; this finds strong energy above the threshold 1024

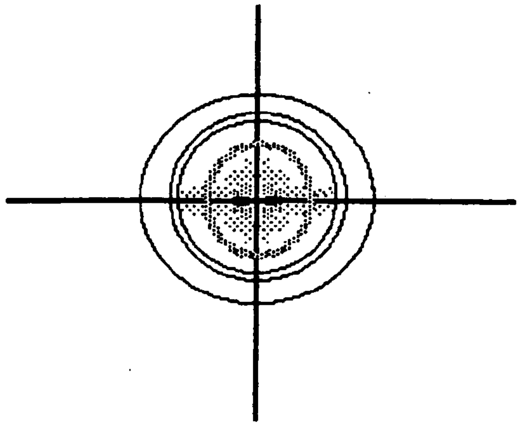
FIG. 33E

As angle is swept from 0 to 90, 45 degrees has highest energy > threshold 1026



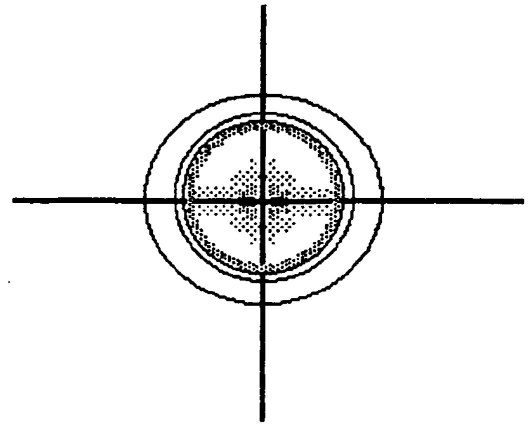
0 degrees 45 degrees 90 degrees

Figure 34A



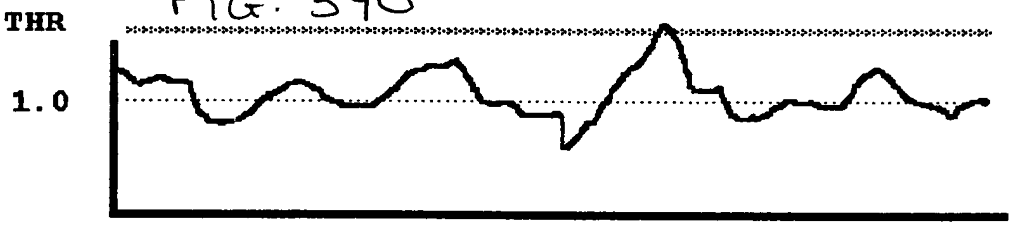
Radius A, 1028

FIG. 34B

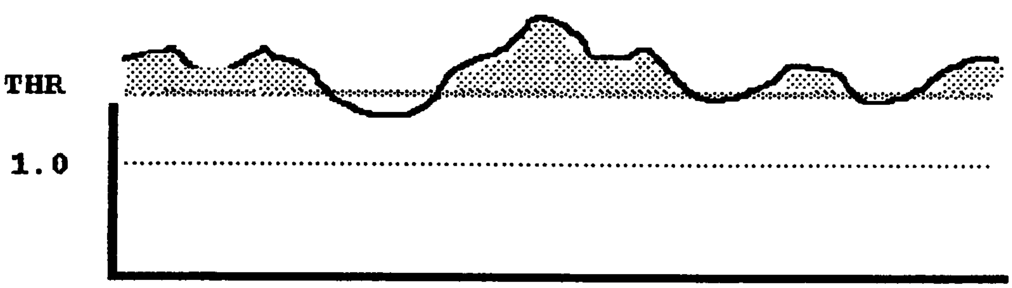


Radius B, 1030

FIG. 34C



Power profile along circle at radius A, 1032



Power profile along circle at raidus B, 1034

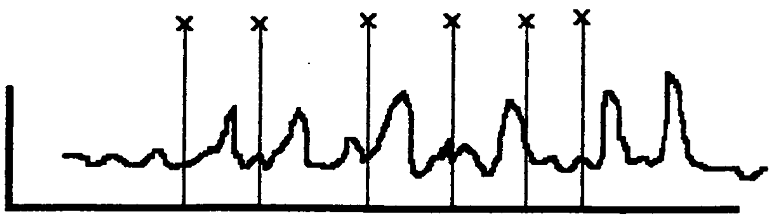
FIG 34D

1036 FIG. 34E

radius, 1040

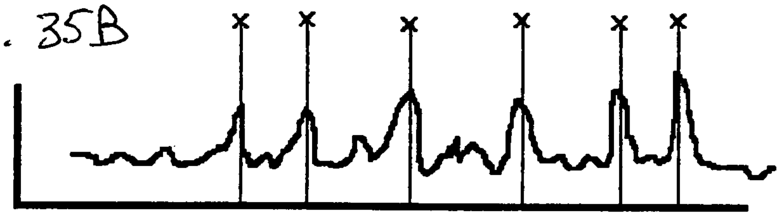
Total integrated power above threshold,
as function of radius 1038

Figure 35A



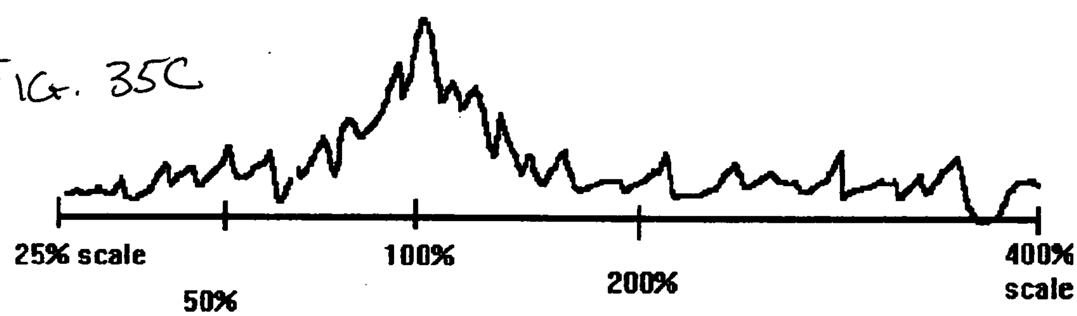
Scale = A; add all power values at the "known" frequencies, 1042

FIG. 35B



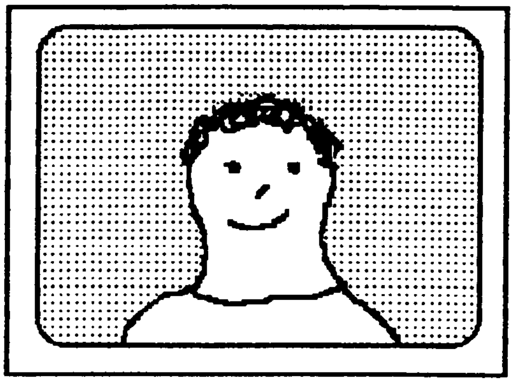
Scale = B; add all power values at the "known frequencies, 1044

FIG. 35C



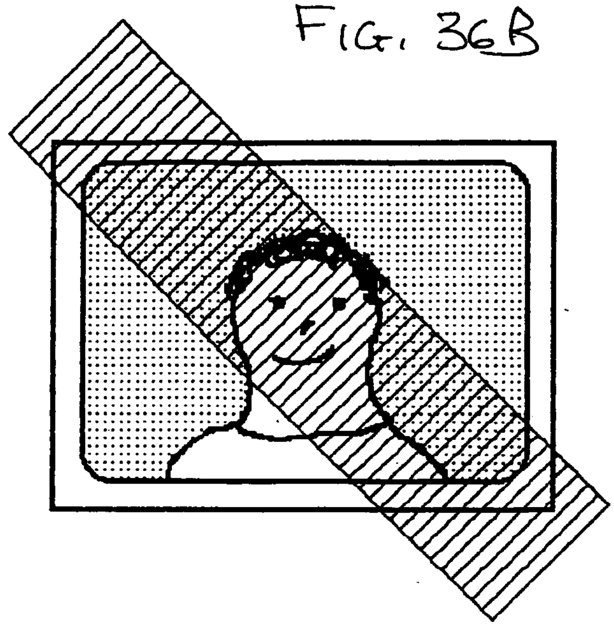
"Scaled-kernel" based matched filter; peak is where the scale of the subliminal grid was found. 1046

Figure 36A



Arbitrary Original Image, 1050, in which subliminal graticules may have been placed

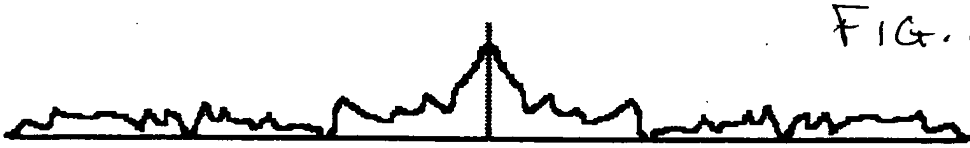
FIG. 36B



"Column scan", 1052 is applied along a given angle through the center of the image

FIG. 36C

FIG. 36D



Magnitude of Fourier Transform of scan data, 1060

Figure 37

Process steps using method of figure A1

1. Scan in photograph
2. 2D FFT
3. Generate 2D Power spectrum, filter with e.g. 3x3 blurring kernel
4. Step angles from 0 degrees through 90 (1/2 deg)
   5. generate normalized vector, with power value as numerator, and moving averaged power value as denominator
   6. integrate values above some threshold, giving a single integrated value for this angle
7. end step on angles
8. Find top one or two or three "peaks" from the angles in loop 4 , then for each peak...
9. Step scale from 25% to 400% ,step ~1.01
   10. Add the normalized power values corresponding to the 'N' scaled frequencies of standard
   11. Keep track of highest value in loop
12. end loop 9 and 8, determine highest value
13. Rotation and scale now found
14. Perform traditional matched filter to find exact spatial offset
15. perform any "fine tuning" to precisely determine rotation, scale, offset